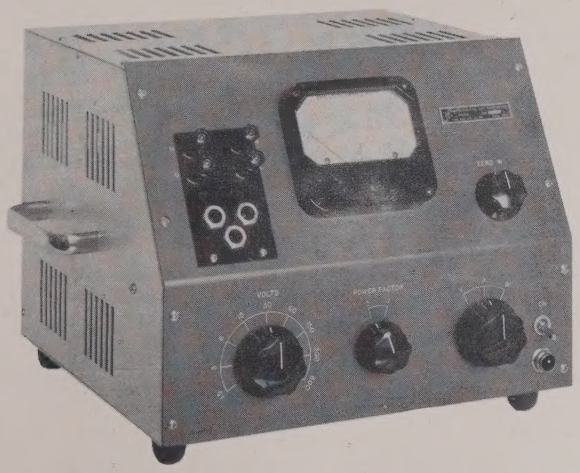
FLUKE

# TECHNICAL DATA

# 102 VAW METER

Measures . . . Volts . . . Amperes . . . Watts



FEATURES

- 20 cps to 100 KC
- 10% and Unity Power Factor Ranges
- 1.5 to 600 Volts AC
- 0.0015 to 30 Amperes
- Negligible Circuit Burden
- True Electrodynamometer Action

## DESCRIPTION

The Model 102 VAW Meter is an ideal instrument for measuring voltage (V), current (A), and power (W) over a wide frequency range. The Model 102 allows direct reading of voltage, current and power on a linear meter scale. Because of its high sensitivity, it is capable of reading power from microwatts to kilowatts. Because of its high input impedance and low shunt drop it produces negligible insertion effects on the circuit under test. Power readings are inherently without waveform error for all frequency components within the specified frequency range.

## APPLICATION

The VAW Meter is ideally suited to measure the true power consumed by a wide variety of loads. This includes both linear and non-linear elements such as servo components, transformers, rectifiers--substantially any power consuming circuit configuration.

In addition, the instrument will be found exceptionally useful in measuring amplifier output power into the actual amplifier load; will, in fact, obsolete the substitution method of utilizing resistance loading for estimating amplifier power output.

| VOLTAGE (FULL-SCALE) | CURRENT (FULL-SCALE) | POWER | POWER FACTOR RANGE | FREQUENCY RESPONSE | ACCURACY | INPUT IMPEDANCE |
|---|---|---|---|---|---|---|
| 1.5 - 600V | 1.5 ma-30A | 225 uw to 18 KW | 1.0 | 20 cps - 100 KC | 3% | 1 megohm 25 uufd |
| | | | 0.1 | 20 cps - 20 KC | 3% | |
| | | | | 20 KC - 40 KC | 5% | |

GENERAL SPECIFICATIONS

VOLTAGE RANGES: 1.5, 3, 6, 15, 30, 60, 150, 300, 600 volts RMS full-scale, selected by voltage range switch on front panel.

CURRENT RANGES: 0.0015, 0.003, 0.006, 0.015, 0.03, 0.06, 0.15, 0.3, 0.6, 1.5, 3, 6, 15, 30 RMS amperes full-scale, selected by plugging in shunts on the front panel.

POWER RANGES: Wattmeter readings are direct readings taking into account the "Power Factor" switch setting of either 0.1 or 1. With the "Power Factor" switch set at 1 the wattmeter reads VA cos $\phi$; with the switch set at 0.1 the wattmeter reads 0.1 VA cos $\phi$. Consequently, the full-scale watts range is from 225 microwatts to 18 kilowatts, or the product of any full-scale current, any full-scale voltage and either 0.1 or 1.

SHUNT DROP: 45 millivolts at full-scale current.

METER SCALES: Voltage, current and power are read on the same meter scales, with the selection of the desired quantity being determined by positioning the "VAW" switch.

INPUT VOLTAGE: 117/220/234 volts, 50 - 60 cps.

ACCESSORIES: Supplied with one shunt of any value listed above under "Current Ranges" as selected by the purchaser. Additional shunts may be purchased as extra equipment.

FINISH: Smooth gray baked enamel on front panel. Front panel machine engraved.

DIMENSIONS: 13" wide, 10" high, 12" deep, exclusive of handles and knobs.

WEIGHT: Net weight, 35 pounds, shipping weight, 52 pounds.

PRICE: $555.00 f.o.b. factory, Mountlake Terrace, Washington, with one shunt of listed rating. Additional shunts are $20.00 each, f.o.b. factory.

The right is reserved without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice

7-31-61-A

Litho in U.S.A.

*Electronics* FOR INDUSTRY

FLUKE

JOHN FLUKE MANUFACTURING CO., INC.

P. O. Box 7428 • Seattle 33, Washington

PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

# MODEL 102 VAW METER

## CALIBRATION PROCEDURE

Prepared by: George Gunby & Owen Green
Engineering Dept.

Revised
October, 1959

EQUIPMENT: H-P 200CD Oscillator
H-P 400L Voltmeter
Power Amplifier
.006A Calibration Shunt
Precision Resistors and Mica Capacitors called for in following instructions

ABBREVIATIONS: VAW = Volts, Amps., Watts Selector Switch
PF = Power Factor Switch
V = Volts Range Switch

## CHECKOUT PROCEDURE

1. Visual Inspection -
   A. All tubes in proper sockets.
   B. Check solder connections - tube sockets and terminal boards.
   C. Check mechanical zero of meter.

2. Put 0 - 750 ma d-c ammeter in series with red tracer (-) and pin 2 (+) of V14 (5Y3).
   Connect nothing to H, G, or L posts - no shunt.
   Set V to 6 v.
   Set PF to 1.
   Set VAW to V or A.
   Turn power on - ammeter should read 110 ma ±15 ma. If okay, remove meter and solder lead in place.

3. Check B+ (pins 3 & 6 of V13). Set to 250 v via P8.
   Check ripple and regulation for 100-130 v line.
   Ripple - 6 mv maximum.
   Regulation - 1.5 v maximum.

4. Check filament voltages. Set 117 v line.
   V5 (pins 2 & 7) = 6.3 v ±.2 v.
   V8 (pins 2 & 7) = 6.3 v ±.2 v.
   Vary line voltage - V8 should stay within 6.0 - 7.1 v.

5. Check electrode potentials
   Pentodes (V2, V4, V5, V7) should read 100-150 v plate and 85-115 v screen.
   V6 should read 150-200 v plate,
   60-90 v screen
   Indicated bias points should read -1.6 v ±0.2 v.

For V1 (6SN7) pin 5 = 160 ± 30 v
pin 2 = 130 ± 30 v
pin 6 = 5.7 ± 1 v

For V9 (6SN7) pin 5 = 210 ± 20 v
pin 2 = 110 ± 20 v
pin 6 = 9 ± 1 v

For V3 & V8 pin 8 = 22 ± 2 v

6. Plug in .006 amp. shunt.
Turn VAW switch to V - meter should read 0.
Turn VAW switch to A - meter should read 0.

If any deflection, check for oscillation at pin 4 of V9 with oscilloscope (input grid of VTVM tube).

7. Full scale V and A.
Set V to 6 v.
Put 1 k across H and G.
Set VAW to V.
Connect H-P400L from L to G.
Set osc. ampl. so that 400L reads 45 mv.

Adjust P2 so that meter indicates fs volts.

Set VAW to A.

Adjust P1 so that meter indicates fs amps.

8. W zero knob range.

Set VAW switch to W. Select V3 and V8 (6V6) to effect meter zero with W zero knob somewhere in its range. Then trim R12 or R32 (150 k) to center W zero knob. Use nothing smaller than 220 k.

9. W scale zero for fs V, zero A.

Set PF to .1.
Set VAW to W and set zero watts.
Set VAW to V.
Connect osc. to H and G and nothing to H and L.
Set osc. to give 80 to 100% fs V.
Switch VAW to W; it should read zero.

If not, adjust P3. If adjustment cannot be made with P3, shunt R54 or R55 to bring P3 in range. Value may be from 0 to 10 k.

10. W Scale zero for fs A, zero V.

Set osc. amplitude to zero.
Short H to G.
Connect osc. in series with 1 k resistor to H and L.
Set VAW to A.
Adjust osc. to give 80-100% fs A.
Switch VAW to W, it should read zero.

If not, trim either R117 or R118. Value may be from 1 mΩ to 10 mΩ.

11. Repeat 9 and 10 above to be sure adjustments have been correctly made.

12. Full scale W, PF = 1.

Set PF to 1.
Connect osc. to H and G.
Put 1 k across H and L.
Connect H-P400L from L to G.
Set osc. amp. so that 400L reads 45 mv.
Set VAW to W.
Adjust P4 for fs watts. It may be necessary to trim R52 to effect adjustment. (Shunt R52 with 100Ω)

13. 6V6 linearity.

Set PF to .1.
Zero W scale.
Set VAW to A.
Set osc. to 2 kc.
Connect osc. to H and G posts.
Connect series load of .1 mfd and 67.5Ω to H and L posts.
Increase gain of osc. to give full scale A reading.
Set VAW to W and note reading.
Turn osc. to zero, change .1 mfd to .4 mfd, switch VAW to A.
Increase gain of osc. to give full scale A reading.
Set VAW to W. Reading should be the same as with the .1 mfd capacitor.

NOTE 1: If the two W readings in 13 above are not identical, replace one or both of the 6V6's, and repeat steps 8 thru 13.

NOTE 2: If it appears that no combination of 6V6's will cause the W readings to coincide, an abnormal circuit condition is indicated. This may be due to unusual non-linearities in the other amplifier tubes, faulty components, or, rarely, an unstable multiplier unit (S-can). There is no reason to suspect improper functioning of the multiplier unit, however, unless all other possible causes of trouble have been eliminated.

14. Full scale W, PF = .1

Set PF to .1.
Connect load of .1 mfd in series with 67.5Ω from H to L.
Zero W scale.
Set VAW to W - it should read 75% fs (27 for fs of 36).

Adjust P6 for 75% fs. If necessary, shunt R53 with 100Ω to effect adjustment.

As a check, change load to .4 mfd in series with 17.5Ω.
Set VAW to A.
Adjust osc. for fs A.
Set VAW to W - should read 25% fs (9 for fs of 36).
Set V to 3V - W should read 50% fs.
Set V to 1.5V - W should read 100% fs.

15. Checkout procedure is complete. Remove shunt and other calibrating equipment, plug 102 in to cook for 40 hours before final calibration.

## FINAL CALIBRATION PROCEDURE

(Allow 15 minute warmup.)

1. Repeat steps 7 thru 13 of checkout procedure.

2. W zero for fs V, no A and fs A, no V, 20 kc.

Repeat steps 9 and 10 in Checkout Procedure, but with osc. set for 20 kc. Do not disturb adjustments made in steps 9 and 10.

If there is more than 1% of fs shift in W zero, some tube in the amplifier chain needs replacing.

3. W reading at 20 kc.

Set osc. to 20 kc and connect to H and G.
Connect load of .01 mfd in series with 67.5Ω across H and L.
Set PF to .1.
Switch VAW to A.
Connect H-P400L across .006A shunt.
Set osc. output to give .006A. (fs)
Set VAW to W - should read 75% fs.

If not, trim R22 with 7-35 mmfd. (C50)

4. Reduce osc. output to zero.

Set V to 1.5V.
Change load to .04 mfd in series with 17.5Ω.
Set VAW to A, adjust osc. for fs A.
Switch VAW to W, should read 100% fs.

If not, trim R103 with 15-100 mmfd.

Switch V to 3V, W should read 50% fs.

5. 20 cps W zero check.

Set osc. amplitude to zero, freq. to 20 cps, and connect to H and G.
Connect load of 5 mfd.
Set V to 6V.
Set PF to .1.
Switch VAW to A.
Increase osc. amplitude to give .006 A.
Switch VAW to W - should read 7.5% fs.

If not, increase or decrease R14 - value should be 1 m - 10 m. If correct results not obtained, check coupling capacitors in amp., particularly C17 which may be increased if necessary.

Check voltage ranges of 15-600V.
Use power amplifier.

6. Set PF to 1.
Set VAW to V.
Set osc. to 2 kc. Connect power amplifier output to H and G.

A. Switch V to 600V.
Change load to 50 k.
Increase osc. amplitude so that H-P400L reads 45 mv.

Check that V reads 300V on 600V scale.

B. Switch V to 300V.
Check that V reads 300V on 300V scale.

C. Decrease osc. amplitude so that H-P400L reads 22.5 mv.
Switch V to 150V.
Check that V reads 150V on 150V scale.

D. Set V to 15V.
Use load of 5 k.
Connect H-P400L Across shunt.
Set osc. amplitude so that H-P400L reads 22.5 mv.

Check that V reads full scale.

E. Switch V to 30V.
Increase osc. amplitude so that H-P400L reads 45 mv.

Check that V reads full scale.

F. Switch V to 60V.
Increase osc. amplitude so that H-P400L reads 45 mv.

Check that V reads 30V on the 60V scale.

## .1 PF VOLTAGE ADJUSTMENTS

7. A. Set V to 60V.
B. Set VAW to A.
C. Set PF to .1.
D. Set osc. amplitude to 0, f to 20 kc, power amplifier output to H and G.
E. Load H and L with .0015 mfd.
F. Set osc. for FSA.
G. Set VAW to W.

W should read .75% fs (1/4 division) - Adjust C41

8. Set V to 30V.
Repeat B, C, D above.
Load H and L with .0025 mfd.
Set osc. for fs A.
Set VAW to W.

W should read 1.5% of fs (1/2 division) - Adjust C47 - May require padding with 39 mmf.

9. Set V to 15V.
Load H and L with .004 mfd (.0015 + .0025)
Set osc. for fs A. W should read 3% of fs - Adjust C46.

10. Set V to 600V.
Load H and L with .00015 mfd.
Set osc. for fs A.

W should read 0 - Adjust C40 (C45 may need to be reduced)

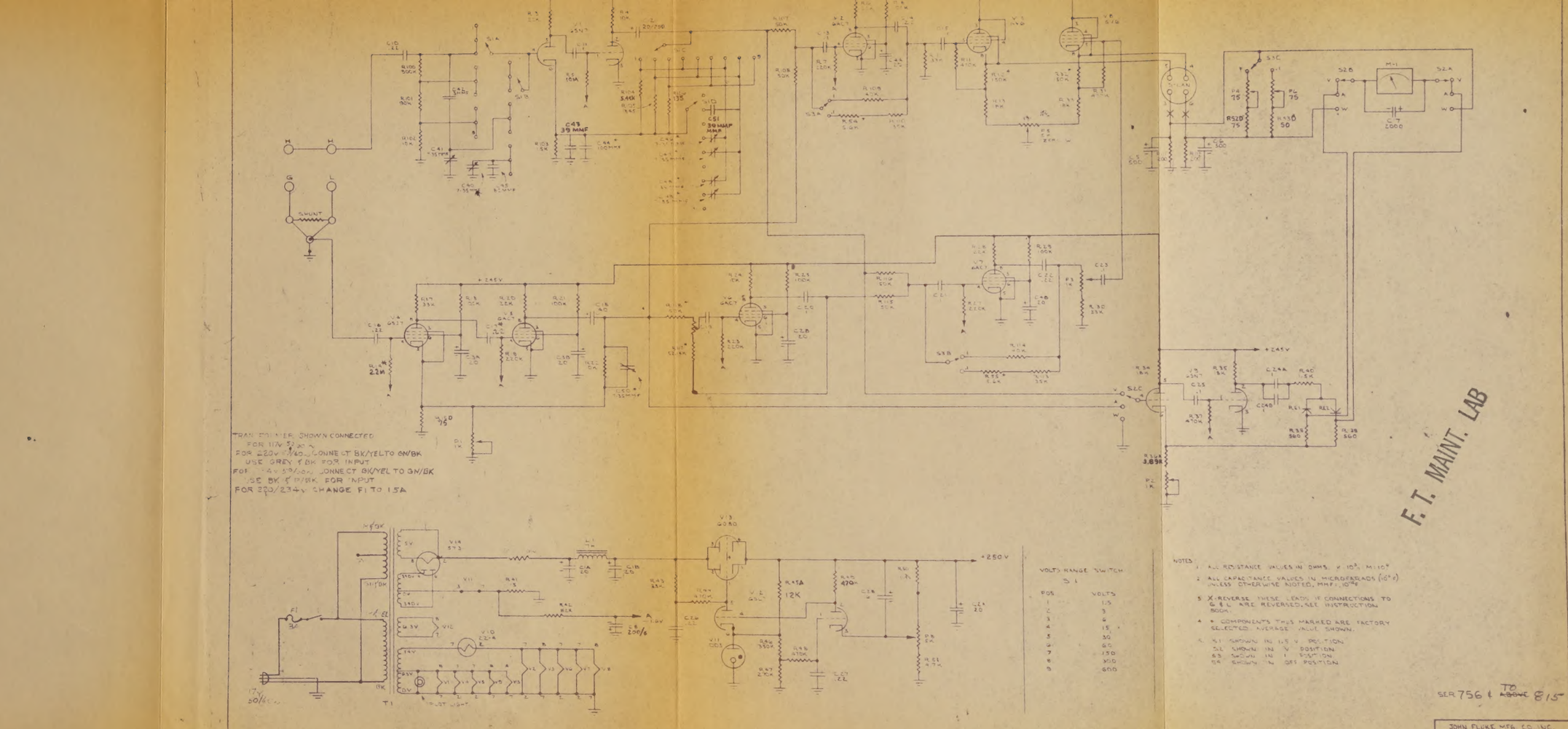
11. Set V to 300V.
Load H and L with .00025 mfd.
Set osc. for fs A.

W should read 0. Adjust C49.

12. Set V to 150V.
Load H and L with .0004 mfd (.00015 + .00025)
Set osc. for fs A.

W should read 0 - Adjust C48 (may require 82 mmf from G to C48)

CALIBRATION COMPLETE


TRANSFORMER SHOWN CONNECTED
FOR 117V 50-60 ~
FOR 220V 50/60~ CONNECT BK/YEL TO GN/BK
USE GREY & BK FOR INPUT
FOR 110V 50/60~ CONNECT BK/YEL TO GN/BK
USE BK & BK/BK FOR INPUT
FOR 220/234V CHANGE F1 TO 1.5A
+245V
+250V
SHUNT
F1
T1
PILOT LIGHT
VOLTS RANGE SWITCH S1
POS VOLTS
1 1.5
2 3
3 6
4 15
5 30
6 60
7 150
8 300
9 600
NOTES:
1. ALL RESISTANCE VALUES IN OHMS, K = 10³, M = 10⁶
2. ALL CAPACITANCE VALUES IN MICROFARADS (10⁻⁶ F) UNLESS OTHERWISE NOTED, MMF = 10⁻¹²
3. X-REVERSE THESE LEADS IF CONNECTIONS TO G & L ARE REVERSED, SEE INSTRUCTION BOOK.
4. * COMPONENTS THUS MARKED ARE FACTORY SELECTED, AVERAGE VALUE SHOWN.
5. S1 SHOWN IN 1.5 V POSITION
S2 SHOWN IN V POSITION
S3 SHOWN IN I POSITION
S4 SHOWN IN OFF POSITION
F.T. MAINT. LAB
SER 756 & TO 815
JOHN FLUKE MFG CO. INC.
SEATTLE, WASH.

www.manualsplus.com
1029165